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SOYBEAN PROCESSING AND UTILIZATION:

A PARTIALLY ANNOTATED BIBLIOGRAPHY

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Compiled by

ANNE HARPER

LEMBAGA ILMU PENGETAHUAN INDONESIA
(INDONESIAN INSTITUTE OF SCIENCES)
Jl. Tjhik Ditiro 43 JAKARTA
1973

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Preface

It is indeed a pleasure to report to the ASEAN member countries the completion of "Soybean Processing and Utilization: a Partially Annotated Bibliography".

The bibliography is compiled within the scope of program proposals made at the first Meeting of the ASEAN Permanent Committee on Science and Technology, held in Jakarta, August 1971. It was mentioned in the report that the meeting considered various projects on problems of common interest in the ASEAN region for joint programs.

During the Second Meeting of the same Committee in Singapore, June 1972, it was agreed that Indonesia should host a Meeting of Experts of the ASEAN member countries to discuss the joint research projects on soyabean processing and utilization. This last Meeting was held in Bandung in September 1972 and several proposals have been accepted for submission to the next Meeting of the ASEAN Permanent Committee on Science and Technology, to be held in Jogjakarta in August 1973.

The bibliography is an attempt to make available citations to research and papers on the subject of soyabean processing and utilization. As its title indicates, the bibliography is a selective one, restricted to references on fermentation products, soybean oil, meal and protein, and nutrition. In Selecting references, bias was given to those concerning the special interest of the ASEAN Experts.

Special appreciation is herewith extended to Mrs.Anne Harper who has made her time available to PDIN (Indonesian National Scientific Documentation Center) to compile the bibliography from start to end, single handed.

July, 1973

Prof. Sarwono Prawirohardjo
Chairman, ASEAN Permanent Committee
on Science and Technology

SOYBEAN PROCESSING AND UTILIZATION : A PARTIALLY ANNOTATED BIBLIOGRAPHY

Introduction

The soybean (Glycine max) owes its importance as a food crop to its high level of protein (40%). Recently interest has focussed on it as a source of protein in countries where supplies of primary proteins are insufficient; soy flours can be incorporated into traditional diets as protein supplements, soy milks made an additional feature of such diets or meat analogs prepared from isolated soy protein. Soy protein, a secondary vegetable protein, closely resembles primary proteins in aminoacid content and ratio. The fat content of soybean (18%) is lower than that for most oilseeds. Nutritionally, soybean is a fairly rich source of vitamins and minerals; however, calcium and phosphorus present are poorly utilised due to the high phytic acid content.

A native of East Asia, where it has been cultivated for more than 2000 years, soybean now undergoes worldwide cultivation. World production, in metric tons, for 1968 was as follows; total 43613, USA 30023, China (Mainland) 10670, Brazil 654, USSR 528, Indonesia 389, Canada 246, Korea 245, Japan 168 and Mexico 112.

In Asia soybean has been traditionally grown for the seed which is used in numerous fresh, fermented and dried food products. Soybean sprouts are eaten as a fresh vegetable and soy milk and related products are popular. Fermented foods are very common, soysauce enjoying most widespread consumption.

Soybean was first used in the USA as a forage crop and for green manure. The seeds were first processed by pressing to yield oil in 1911. Hydraulic or screw pressing leaves 4 to 5% of the oil in the presscake. Most processing plants now use hydrocarbon solvent extraction of oil which leaves about 1% of oil in the meal. Soybean oil contains 85% unsaturated glycerides (linoleic, 55%, oleic, 25%, and linolenic 5%) and is classed as a semidrying oil. The low fatty -acid content (15%, mainly palmitic and stearic) results in low refining loss and a high yield of refined oil. Cooking oils and salad oils are prepared by refining, bleaching and deodorizing. By controlled hydrogenation, solid fat can be prepared for use in shortening and margarine. Crude soybean oil contains 1-3% lecithin, an antioxidant, emulsifier and softener used in food manufacturing and many other industries.

Soybean meal, remaining after the oil has been solvent extracted, is especially important as a high protein feed for livestock and poultry.From the meal,soy flour,grits and flakes are prepared and

used in food manufacture; e.g. bread, sausage binding and noodles. Meal is also the source from which pure soy protein is isolated. While whole soybeans are generally used in preparation of soysauce by fermentation, meal is used by many manufacturers in its preparation by the more rapid acid hydrolysis method. Monosodium glutamate, an important condiment in the Orient and the USA and a essential constituent of soysauce, can be prepared by the acid hydrolysis of soybean meal.

Although soybean has major importance as a food, it has numerous uses in other industries. The oil is used in manufacture of enamels, varnishes, alkyd resin paints, inks and stains, sealing and caulking compounds, linoleum and oilcloth, pharmaceuticals, cosmetics, synthetic rubbers and core oils. Processed soy protein has similar properties in viscosity and adhesive strength to casein. It is used in the manufacture of adhesives (especially glues for the ply wood industry), paper coatings, water-thinned paints, plastics, textile fibres, fire foam stabilizers, printing inks, fillers, core binders, stickers for agricultural sprays, linoleum, emulsifying agents, paper and textile sizing and leather finishes.

Scope of the bibliography.

The bibliography excludes references to non-alimentary utilisation of soybeans. It also excludes references to alimentary utilisation where the harvested plant has not undergone processing by either fermentation or oil extraction. References are presented under four subject headings:

1. General.
2. Fermentation products : Processing and chemistry of fermented foods(prepared using a living microorganism at some stage),microbiology of fermentation, commercial production of soy sauce by chemical hydrolysis.
3. Soybean oil, meal and protein : Solvent extraction of soybeans, stability of soybean oils, processing of the meal, isolation, characterization and processing of soy protein.
4. Nutrition : The role of soybean products in nutrition of humans, livestock, poultry and laboratory animals.

Where reference papers have been seen, short indicative notes on content are supplied in parenthesis : numbers of figures, tables and references in these papers are also given (Fig. Tab. Ref.).

Terminology of soybean processing.

Soybean meal

Soy flours and grits contain 50% protein. They are the screened and

graded product after expelling or extracting most of the oil from selected, sound, clean, dehulled yellow soybeans. Food grade hexane is commonly used for extraction. In solvent extraction, beans or flakes are soaked in the solvent. The oil dissolves in the solvent to form a mixture called the miscella which drains away from the meal. Oil can be recovered from the miscella. The meal is desolventized to yield a product with low oil and high protein content. Most efficient solvent extraction is by a continuous flooded process avoiding back mixing of weaker and richer miscellas. Desolventizing of extracted soy flakes involves simultaneous elimination of solvent, destruction of urease and toasting of the meal, achieved using a desolventizer-toaster. After this process, the toasted meal must be ground or sieved to obtain flour of proper fineness or grits, as required. Flours are classified according to their oil content:-

Defatted soy flour - less than 2% residual oil
Low-fat soy flour - 5 to 6% residual oil
High-fat soy flour - approximately 15% residual oil
Full-fat soy flour - all original oil present (18-20%)
Lecithinated soy flour - low-fat or high-fat soy flour with lecithin added at levels up to 15% composition

Soy protein concentrates contain a minimum of 70% protein on a moisture-free basis. These flours are obtained by leaching out oligosaccharides, mineral matter and other soluble constituents from regular soy flour with acidified water or aqueous alcohol. Alternatively, defatted material is initially heat denatured using moist heat and later extracted with water. Such concentrates have improved flavor and superior fat-and water-binding properties.

Soy milk, a suspension of soy flour in water, is a beverage widely used in China, Japan, Taiwan and Thailand. Saridele is concentrated, spray-dried soy milk. Boiled soy milk yields a protein-rich film, yuba. Soybean curd (tofu, tahu) is prepared by coagulating soy milk with calcium salts; related products are aburge (fried bean curd) and koritofu (dried bean curd).

Soy protein isolate

Protein is isolated from defatted soyflakes with a high protein dispersibility index. The protein is extracted with an aqueous alkaline medium, the extract clarified and the major globulin precipitated at pH 4.5. The protein curd is concentrated, washed, neutralised and spray dried: it is 90% pure, on a moisture free basis. In the last decade meat analogs, protein fibre or extrusion-expansion products, have been made.

Protein fibre products are made by forcing viscous solutions of 15-20% dissolved spinnable protein through spinnerettes into a precipitating bath containing an aqueous solution of acids and inorganic

salts.

Extrusion-expansion products are made by subjecting full-fat soy flours, grits, meals or concentrates to short path high energy, temperature and pressure processing. The structure of the product is based on steam-generated voids in a denatured protein lattice. Since soy flours rather than isolated protein can be used as starting product, these products are more economic than protein fibre products.

Fermentation products

Fermentation can be used to increase food value of a non-protein substrate by microorganismal conversion of carbohydrates to aminoacids. This applies in the processing of ontjom (ontjom merah) by fermentation of soybean waste, after extraction of protein, by Neurospora sitophila. However, generally with the high-protein plant soybean, the function of fermentation is to make the product more palatable by hydrolysis of proteins to aminoacids or, traditionally, to mask the beany flavor or bitterness and overcome the poor cooking quality. (Recently it has been discovered that the bitter flavor is not inherent in the bean but develops when cells are broken in the presence of moisture due to activation of lipoxidase. This enzyme can be inactivated in the early stages of processing.)

Soysauce (shoyu) is produced throughout East Asia by fermenting soybeans with a strain of Aspergillus oryzae or A. soyae with high proteolytic activity. This fungus is cultured on a mixture of wheat bran and soybean flour, koji. The koji is mixed with an equal volume of saline water to form the mash (moromi) which is processed into soysauce. The ratio of soybean to wheat greatly influences the flavor: tamari sauces have a high ratio while koikuchi sauces have equal levels of wheat and soybean in the koji.
Natto and miso are popular foods in Japan, the latter resulting from soybean fermentation with an Aspergillus oryzae strain high in amylolytic as well as proteolytic activity or, for an expensive product, by fermentation with Neurospora sitophila.
Tempeh, a traditional Indonesian food, results from fermentation of beans by Rhizopus oligosporus.
Soybean cheese (sufu) is prepared by innoculating soy milk or bean curd with a starter organism (e.g. Mucor sufu).

In selecting agents for fermentation, it is important that they should be non-toxic to humans and should not produce toxic metabolites. Also, conditions favoring their development may also favor development of other organisms which may be harmful or may alter the pattern of fermentation unfavorably. Among the numerous yeasts found in soysauce mash, Zygosaccharomyces sulsus, Z. japonicus, Pichia and Torula are considered to be harmful to its fermentation while Z. major and Z. soyae are believed to play a role in normal fermentation.

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Besides Asp.oryzae or Asp.soyae, Monilia, Penicillium and Rhizopus are sometimes found in the mash (koji - wheat bran+ soybean flour+mold - and saline water). However these molds are believed to have no role in proper aging. A number of yeasts are present in mash and also some bacteria." 5Fig.18Tab.236Ref.

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